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Case Report

Dual Left Anterior Descending Artery: Clinical Overview and Interventional Management

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Abstract

Congenital coronary artery anomalies are relatively rare, occurring in approximately 0.6%-1.3% of cases undergoing coronary angiography. Among these anomalies, a unique cardiac abnormality known as a dual left anterior descending artery (LAD) stands out. A dual LAD is characterized by the presence of 2 LADs in the anterior interventricular sulcus. This structural deviation consists of a shorter LAD that terminates high in the anterior interventricular sulcus and a longer LAD that extends to the distal sulcus, supplying blood to the cardiac apex. Percutaneous procedures on dual LADs are even less frequent. We describe a 53-year-old woman with typical burning chest pain, ST-elevation in leads I and aVL, and positive troponin I enzyme. Coronary angiography revealed a thrombotic lesion with 99% stenosis at the proximal part of the LAD. The main LAD originated properly from the left coronary cusp, and the remainder of its course was supplied by a second branch originating from the right coronary cusp. Computed tomography angiography and echocardiography were performed for the LAD course. The patient was discharged after an uneventful 1-week hospital stay.

Our case is particularly noteworthy for several reasons. Firstly, this dual LAD anomaly is uncommon, and patients with dual LADs less frequently have a ramus artery. Secondly, there have been only a few documented cases of percutaneous transluminal coronary angioplasty performed on short LADs. The key takeaway from this scintillating case study is the significance of identifying the artery responsible for blood supply to the cardiac apex.

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Introduction

Congenital anomalies involving the left coronary artery and the right coronary cusp are rare.[1] The most common congenital coronary artery abnormality is the separate origin of the left anterior descending artery (LAD) and the left circumflex artery (LCX), with an incidence of 0.41%, followed by LCX arising from the right coronary artery (RCA), with an incidence of 0.37%.[2, 3] The LAD has the most consistent course among the coronary arteries.[4] LAD

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duplication is an uncommon abnormality. There are a few reports on the coronary computed tomography angiography (CCTA) appearance of this uncommon entity, despite the infrequent descriptions of its angiographic findings.[5] Spindola-Franco et al[6] (1983) were the first to characterize and categorize a dual LAD as a small LAD finishing high in the anterior interventricular groove and a long LAD. A small LAD that terminates high in the anterior interventricular groove and a long LAD constitute a dual LAD. It often develops as an early branch of the LAD proper (types I–III) and seldom develops abnormally from the RCA (type IV).[7]

This paper aims to show a sporadic rare anomalous origin of the LAD from the right coronary cusp.

Case Report

A 53-year-old woman with a history of hypertension and psychological disorder presented to the emergency department with complaints of typical burning left chest pain radiating to the back, lasting approximately 20-30 minutes and associated with nausea and vomiting. Her pain began after emotional stress triggered by her brother's sudden cardiac death at age 35. A physical examination revealed that the patient was afebrile, exhibited no abnormal heart or respiratory sounds, and had a blood pressure of 132/92 mm Hg, a heart rate of 76 beats per minute, an oxygen saturation level exceeding 95%, and a respiratory rate of 12 per minute. Electrocardiography showed normal sinus rhythm with ST-elevation (STE) in leads I and aVL and reciprocal ST-segment depression in the inferior leads (II, III, and aVF), presenting a lateral ST-elevation myocardial infarction (STEMI). The chest X-ray was normal. The maximum cardiac troponin level was 31 µg/L (ULN ≤0.05 µg/L) within 8 hours of presentation. With a clinical diagnosis of STEMI, the patient was treated according to STEMI guidelines, and aspirin, statin, and clopidogrel were started. She was prepared for coronary angiography.

Via the femoral method, a guiding catheter with a 6 Fr sheath was inserted around the coronary ostium of the left coronary artery to insert the coronary wire into the LAD. Following guiding catheter stabilization, angiography revealed a thrombotic lesion with 99% stenosis at the proximal part of the LAD, and the LAD artery was diminutive (Figure 1A).

After passing a 0.014-inch coronary guidewire through the lesion, balloon angioplasty was performed using a 1.5×15 mm balloon (MOZEC). A 3.0×32 mm drug-eluting stent (SUPRAFLEX) was implanted using adjuvant ballooning performed with a 2.0×20 mm balloon (WILMA) (Figure 1B).

The LAD was extremely small and supplied only the proximal myocardium, raising suspicions about coronary anomalies. Non-selective angiography raised the suspicion of a dual LAD originating from the right coronary cusp (Figure 1 C & D). Simultaneous injection of left and right cusps was carried out for a thorough review. Both coronary artery routes were visualized. The main LAD originated properly from the left coronary cusp and gave rise to some diagonal and septal branches, and it was distally diminutive. Consequently, the remainder of its course was supplied by a second branch originating from the right coronary cusp, which had its own septal perforators (Figure 1 E & F).

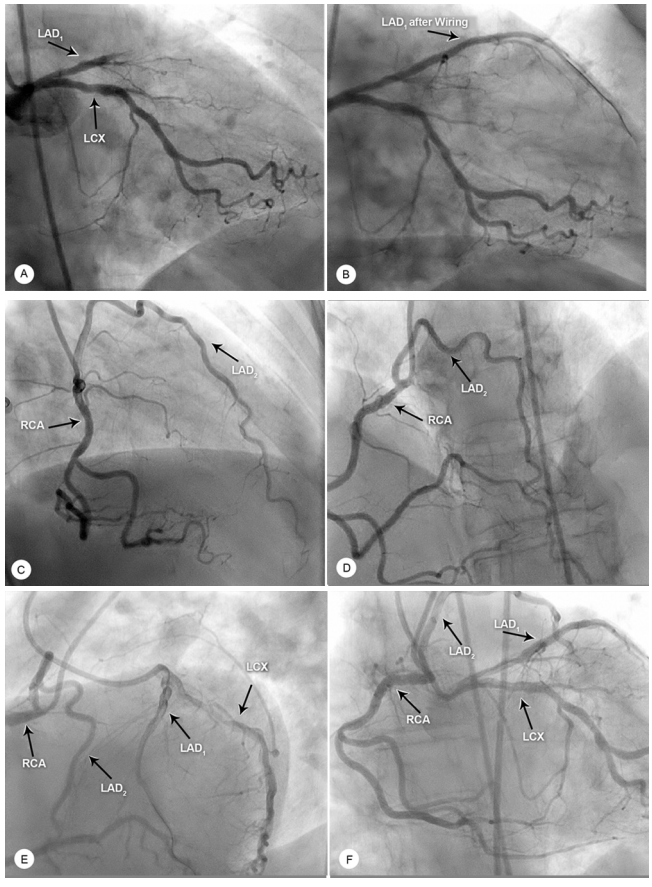

Figure 1. The images illustrate a conventional coronary angiography of a dual LAD. LAD_1 (the short LAD) originated from the common LAD and terminated in the proximal AIVS after supplying a few septal branches (A & B). The angiography of the short LAD revealed a stenotic cut from the proximal part (A). The selective angiography of LAD_2 (the long LAD), which originated separately from the RCS, demonstrated an initial slight upward horizontal course that gave rise to septal perforators and then turned downwards to supply the mid and distal interventricular septum (C & D).
Left anterior caudal view simultaneous injection of both coronary arteries demonstrated the separate origin of LAD_1 and LAD_2 from the LMCA and RCA (E & F).
LAD, Left anterior descending artery; RCA, Right coronary artery; RCS, Right coronary sinus; LCX, Left circumflex artery; AIVS, Anterior interventricular sulcus; LMCA, Left main coronary artery

The patient was in good condition, and the angiography was terminated. A day later, CCTA to establish the coronary system course revealed that the proximal and partial LAD originated from the left cusp with a patent stent and some soft plaques, a remnant of the LAD from the right sinus of Valsalva with a mid-to-distal course. No inter-

arterial compression was seen (Figure 2). Comprehensive transthoracic echocardiography showed normal left ventricular (LV) and right ventricular (RV) size and function with an LV ejection fraction of 55%. The short-axis view in the aortic valve level showed an RCA diameter of 3.7 mm, which normally originated from the right coronary cusp. The remnant of the LAD abnormally originated from the right coronary cusp with an anterior course (Figure 3). Following angiography and CCTA, our patient showed no signs of major creatinine level increases or renal problems.

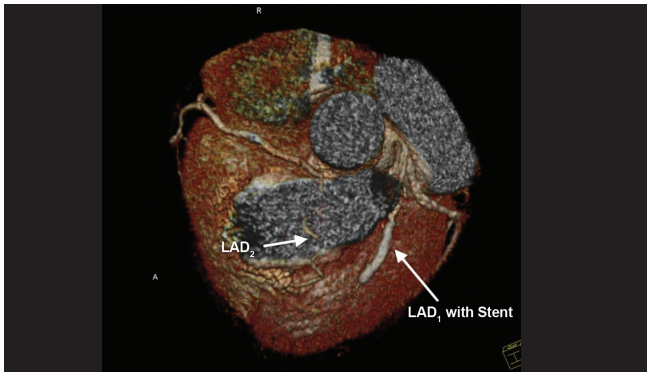

Figure 2. Multi-detector computed tomography coronary angiography of the dual LAD is presented herein, revealing a separate origin from the RCS of LAD_2.
RCS, Right coronary sinus; LAD, Left anterior descending

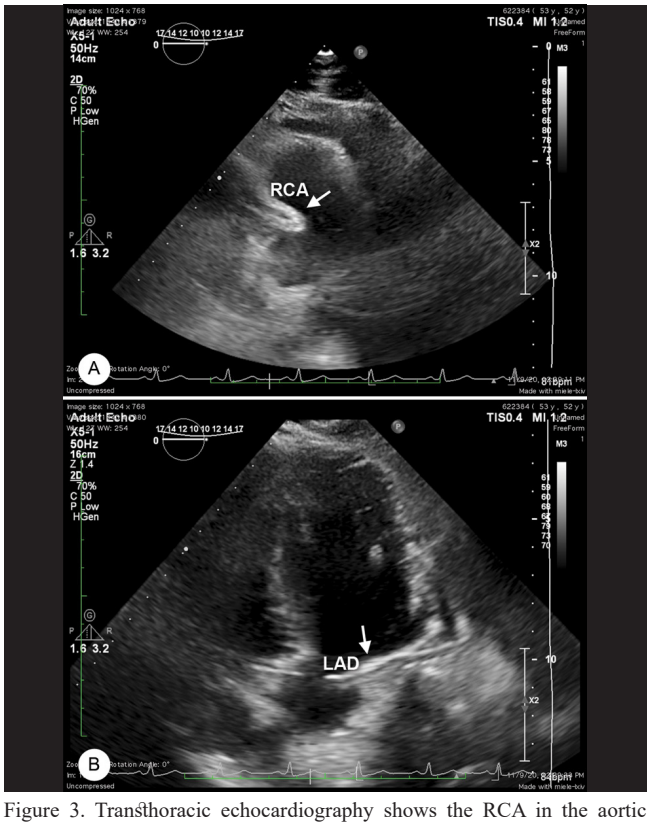

Figure 3. Transthoracic echocardiography shows the RCA in the aortic short-axis view (A) and LAD_1 and LAD_2 in the 5-chamber view (B).
RCS, Right coronary sinus; LAD, Left anterior descending

Discussion

A dual or double LAD refers to a variant of the LAD in which 2 distinct arteries supply all or a portion of its combined territorial targets. A dual LAD anomaly is recognized by the presence of 2 distinct LAD components, often a short LAD and a long LAD.[8] Based on their lengths, this separation of the LAD into the short LAD and the long LAD conforms to the typical path of a single LAD in the anterior interventricular septum.[9] The short LAD typically extends to the mid-septum but can also end high in the proximal portion. Although the proximal route of the long LAD frequently varies and goes beyond the usual pathway, it can emerge in the main or independent ostium of the RCA in the right coronary sinus cusp. The consistent or typical characteristic is that it reaches the distal of the anterior interventricular septum. While the short LAD comes from the distal septal perforators, the distal LV diagonals, and occasionally even the RV diagonals, the long LAD largely originates from the proximal septal perforators, the proximal LV diagonals, and occasionally the RV diagonals.[10]

Since Spindola-Franco's first categorization, research has revealed 12 different forms of dual LADs.[6] Additionally, multiple instances of overlapping dual LAD variations have been reported, which increases the uncertainty. What has also created further ambiguity is the fact that numerous dual LAD cases have been unclassified.[11] After excluding the least prominent characteristics serving as the foundation for earlier classifications, Jariwala et al[12] offered a new classification of the LAD based on angiographic and autopsy findings to eliminate the ambiguity caused by a rising number of dual LAD cases (Table 1).

The majority of dual LAD abnormalities are asymptomatic, and about 20% have symptoms. The most frequent symptom of patients in previous research on double LADs, as well as our case, was chest pain.[13]

The anterior wall of the LV was supplied by 2 LADs in our patient. The first one emerged from the left main coronary system and abruptly came to an end after diagonal branches. The second one originated from the right coronary cusp. The mid and distal regions of the left anterior interventricular septum were reached after it provided several septal branches. The septal branches and route of the anomalous artery served as evidence that it was the LAD unless this abnormal artery was a fully-grown conus branch functioning in lieu of the LAD.[14]

Diagnosis is mainly based on the clinical suspicion of the anomalous origin of the coronary artery. Coronary magnetic resonance angiography, CCTA, and transthoracic echocardiography are valuable noninvasive diagnostic techniques in such cases. Coronary angiography is the gold standard in anomalous coronary artery diagnosis and assessment and is of special relevance where noninvasive tests are nondiagnostic.[15]

Table 1. New classification of the LAD based on angiographic findings[12]

Group I or the "split" dual LAD system	Usual features	The entire left coronary artery and its major branches arise from the LCS. Typically, the LMCA separates into the LAD and the LCX. The proper or common LAD bifurcates into LAD_1 and LAD_2. LAD_1: terminates in the proximal AIVS and predominantly gives rise to the septal branches. LAD_2: traverses epicardially with a deviated course either on the LV or RV side or intramyocardially to re-enter the distal AIVS, which terminates either at the apex or may continue beyond the apex.
	Subgroups	Group I is further divided into 3 subgroups depending on a single clinically relevant variable like the course of LAD_2 as follows: anterior or epicardial [A], septal or intramyocardial [S], and combined.
	Variable features	• Early or separate origin of LAD1 from the LMCA or the LCS • Absence of the common LAD—separate origins of LAD1 and LAD2 from the LMCA • Epicardial LV or RV course of LAD_2 • Equal or reverse lengths of LAD_1 and LAD_2 • Branching pattern—a trifurcation lesion involving a large diagonal branch, LAD_1, and LAD_2 • Associated coronary anomalies—a triple LAD anomaly, a hyperdominant LAD, and the congenital absence of the LCX
Group II or the "true" dual LAD system	Usual features	• The left coronary artery originates partially from the LCS and the RCS. • Usually, the LMCA is divided into LAD_1 and the LCX. • LAD_1: can be called a "left-sided LAD" terminating in the proximal AIVS. This course is relatively unaltered. • LAD_2: can be called a "right-sided LAD" originating from the RCS or any segment of the RCA. Typically, the proximal segment of LAD_2 follows a variable path, while its distal segment has a constant course that re-enters the distal AIVS to terminate into the LV apex.
	Subgroups	• Group II is further divided into 5 subgroups depending on a single clinically relevant variable like the course of LAD_2 as follows: the anterior free wall or prepulmonic [A], inter-arterial [B], posterior or retro-aortic [P], septal or intramyocardial [S], and combined.
	Variable features	• Absence of the LMCA and separate origins of LAD_1 and the LCX from the LCS. • Separate or common origins of LAD_2 from either the RCS or the proximal or mid-segment of the RCA • Equal or reverse lengths of LAD1 and LAD_2 • Branching pattern—After entering the superior aspect of the AIVS, LAD_2 provides a small septal perforator, or LAD_1 gives off a large diagonal branch. • Associated coronary anomalies—the anomalous origin of the LCX from the RCS or an intercoronary communication
Group III or the "anomalous" dual LAD system	Usual features	The entire left coronary system arises from the RCS and lacks a constant morphological feature.
	Subgroups	Group III is further divided into 5 subgroups depending on a single clinically relevant variable like the course of the LMCA, LAD_1, and LAD_2 as follows: anterior free wall or prepulmonic [A], inter-arterial [B], posterior or retro-aortic [P], septal or intramyocardial [S], and combined.
	Variable features	There are several variables with either combined or separate origins of the LMCA, LAD_1, and LAD_2 from either the RCS or the RCA contributing to various combinations as follows: • Origin of the LMCA: Separately from the RCS or the common ostium with the RCA or the proximal segment of the RCA • The LMCA bifurcates into LAD_1 and LAD_2, each of which traverses to the left side to reach the AIVS and follows a pattern of distribution like the group I dual LAD. • The LMCA bifurcates into LAD_1 and the LCX and traverses to the left side. LAD_1 terminates in the proximal AIVS. There is a separate origin of LAD_2 from the RCS or the RCA supplying the mid and distal AIVS. It follows the pattern of distribution like the group II dual LAD. • Absence of the LMCA and the separate origins of LAD_1 and LAD_2 from either the RCS or the RCA • Equal or reverse lengths of LAD_1 and LAD_2—not reported in the literature • Branching pattern—LAD_1 supplies all the septal and diagonal branches. • Associated coronary anomalies—The joint origin of the LMCA and the RCA (single coronary artery pattern) from the RCS is categorized as the anomalous coronary artery origin from the ACAOS.

LCS, Left coronary sinus; LMCA, Left main coronary artery; LCX, Circumflex branch of the left coronary artery; LAD, Left coronary artery; AIVS, Anterior interventricular sulcus; LV, Left ventricular; RV, Right ventricular; RCA, Right coronary artery; RCS, Right coronary sinus; ACAOS, Anomalous coronary artery origin from the opposite sinus

Dual LAD cases are critical for various reasons. Planning surgical revascularization requires a precise understanding of the anatomy of the coronary artery.[15] If just the short LAD is transplanted, the surgeon must be aware of anatomic characteristics to expose the artery higher than normal in the anterior interventricular sulcus. Understanding the different dual LAD types is crucial to the revascularization of the correct arterial system and the prevention of inappropriate arteriotomy.[17] The anterior LV wall and the septum may receive their blood supply from the 2 separate arteries; therefore, grafts to both vessels may be required if both the short and long LADs are significantly stenosed.[12,16] Furthermore, different anatomic characteristics at regular coronary angiography might be mistaken for mid-LAD occlusion since the extra artery cannot be seen, especially when the long LAD originates from the right coronary cusp. Because the main septal perforators often originate from the short LAD and the major diagonal arteries typically originate from the long LAD, this mistake might result in unusual and seemingly disparate observations of coronary artery lesions and regional wall motion abnormalities.[12,18] In a previously published case, the anterior interventricular septum was isolated akinetic when the short LAD (in type I dual LAD) was occluded with a normal LAD proper and a long LAD.[6,19]

Conclusion

Overall, when we encounter a short LAD during routine angiography, especially if we do not identify any coronary arteries feeding the LV apical region, it is crucial to consider an additional LAD coronary artery. In cases with dual LADs, deciding whether or not to intervene is challenging, especially if a ramus with undesirable angles is present. Angioplasty with stenting, even to a short LAD, conferred beneficial results to our patient at 12 months of follow-up, even though coronary artery bypass graft surgery is more common in these patients. In symptomatic patients, a definitive diagnosis using coronary angiography and intervention is crucial. Data on the outcome of surgical interventions in asymptomatic patients are still lacking. Noninvasive tests, such as echocardiography and CCTA, can aid in diagnosis and are becoming increasingly popular.

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